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13. ABSTRACT (Maximum 200 words) This Grant End Report for the US-Japan Industry and Technology Management Training Program covers the accomplishments of the grantee for the period covering November 1, 1994 to September 1, 2000. The report presents accomplishments relative to stated program goals, results of cooperative efforts with the other grantees, and the Program's activities in research, the Business Technical Japanese Language Program, internships and fellowships, outreach, and dissemination through lectures, conferences, workshops, newsletters, academic publications and presentations.			
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GRANT END REPORT

FOR THE

UNITED STATES-JAPAN INDUSTRY AND
TECHNOLOGY MANAGEMENT TRAINING PROGRAM

SUBMITTED TO THE

AIR FORCE OFFICE OF SCIENTIFIC RESEARCH

GRANT #F49620-95-1-0042

ADMINISTERED BY THE

INSTITUTE OF MANAGEMENT, INNOVATION &
ORGANIZATION
HAAS SCHOOL OF BUSINESS
UNIVERSITY OF CALIFORNIA, BERKELEY

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GRANT END REPORT
FOR THE
UNITED STATES-JAPAN INDUSTRY AND
TECHNOLOGY MANAGEMENT TRAINING PROGRAM
GRANT #F49620-95-1-0042

This Progress Report covers the accomplishments and plans of the United States-Japan Industry and Technology Management Training (USJITMT) Program at UC Berkeley from the period November 1, 1994 through August 2000.

These grant funds assisted in making substantial progress toward achieving the goals and objectives in our AFOSR funded USJITMT Program. We funded students, faculty, research projects, and the Management of Technology Program one of whose objectives is to increase the understanding of Japanese and U.S. industry and technology management. We have set-up and continue to run a language program in intensive business and technical Japanese. We are providing mechanisms to work with the Department of Defense and Department of Energy laboratories and have several on-going projects with various National Labs. We support a variety of dissemination activities for cooperative partnerships between U.S. industry, academia, and government to employ the results of our program.

I. RESEARCH

Our varied research projects supported by AFOSR funds have been successfully concluded. Each project and its results are listed below.

Project I. Software's Growing Importance in U.S.-Japanese High-Technology Competition and Management. Professors David Mowery and Sara Beckman.

This research topic consisted of two parts. The first part, coordinated by Professor Sara Beckman, concerned managing hardware-software integration in the development of complex systems. The second topic, handled by Professor David Mowery, concerned the role of university research in the growth of the U.S. and Japanese software industry.

Part 1. One of the greatest challenges in developing new software product is defining the product and then managing that product definition throughout the development process. Research for these topics has focused on the processes employed by software developers to define the products they plan to develop – understanding customer needs, assessing position relative to the competition, choosing technologies and platforms – and then managing changes to that product definition during development. An extensive survey of

20 development projects in the United States and 20 in Japan yielded interesting data on the varying practices employed.

Japanese firms come from a heritage of customer software development where they had to form close ties with their customers. Because of this, the Japanese had difficulty making the transition to packaged software sold in the consumer market, in part because their product definition approaches needed to change to accommodate the larger market size. Differences were also found between database and network product developers and applications product developers, as the applications developers tended to have highly sophisticated systems for interacting with developers while the database developers were more technically driven. This finding led to the belief that there may not be a single best way to do product definition. In keeping with efforts to build collaborative relationships with Stanford University, Professor Beckman presented these findings to the Stanford Computer Industry Project Colloquium.

Part 2. Professor David Mowery continued his research in a number of areas of relevance to the goals of the US-Japan Industry and Technology Management Training program, including: (i) the development of the U.S. and global computer software industries; (ii) the factors affecting the performance of U.S., Japanese, South Korean, European, and Taiwanese firms in developing new process technologies and transferring them to their manufacturing facilities; (iii) the organization and management of cooperative R&D activities in the United States and other industrial economies; and (iv) U.S. technology and international trade policies. Professor Mowery testified on issues (ii) and (iii) before the Federal Trade Commission, and was invited to lecture on these and related topics at the International Innovation Management Institute, University of Bern. Professor Mowery presented the following: papers on the software industry at Stanford University; talk on the management of new process innovation to the Canadian Institute for Advanced Research; paper on the post-war development of high-technology industries in the U.S. economy at the OECD conference on "Innovation, Creativity, and Job Creation," Oslo, Norway (see publications for a more complete list).

Project II. *Quality Assurance and Open Architecture Computing.* Professor Paul Wright.

Manufacturing process technologies must be responsive to changing consumer requirements for quality, variety, and low cost. In order to meet market demand, the development of innovations based upon computer technologies is critical. The focus of this research project was to investigate what computer technologies are needed to support manufacturing innovation. The system developed and tested at UC Berkeley is the IMADE system (Integrated Manufacturing and Design Environments). The IMADE system is a complete system for design, process planning, and fabrication. It includes the following three components:

1. **User Friendly Design Interface:** DUCADE (Domain Unified ComputerAided Design Environment). A computer-aided design environment that provides tools to aid both the mechanical and electrical engineer.

2. Process Planner Module: The planner contains a large number of algorithms for set up and tool path planning, as well as knowledge of the current tools available on the milling machine.
3. Open-architecture Networked Intelligent Hardware: A customized milling machine with integrated sensors for on-machine inspection.

Over the past several years, significant advances have been accomplished in implementing the IMADE system. These efforts have been facilitated by visits to Japanese firms and consultation with Japanese engineers. Several electronics were targeted for study. Professor Paul Wright made a trip to Sony and Panasonic facilities in Japan to gather data and to further compare approaches to rapid prototyping. The following paragraphs briefly review the status of the components as well as a discussion for future work on the project.

The key element to the IMADE system is DUCADE. In the past, unlike their Japanese counterparts, U.S. consumer electronic firms had their mechanical and electrical design engineers work independently on product design. The negative consequences of this approach are poor quality and productivity; it became known as "over-the-wall engineering." In an effort to promote cooperative design between disciplines, DUCADE was developed. By integrating design environments across the mechanical and electrical engineering domains, DUCADE facilitates smooth communication between designers, which results in cleaner product designs. This is accomplished by integrating design tools into a generic framework – a user-friendly environment. Thus, DUCADE is configured to run several different mechanical and electrical CAD packages such as Pro-Engineer, AutoCAD, and Racal. Moreover, the information and design data generated by these design tools are organized into a uniform database. This allows access to a product's design by all designers through a common interface, thereby eliminating "over-the-wall engineering."

DUCADE was used to develop a prototype wireless computer terminal called InfoPad, that has a customized PCB with more than 200 electronic components, to use between UC Berkeley's Wireless Computing Consortium and the Integrated Manufacturing Laboratory. A second DUCADE-related project is the Mechanical Assembly Planner (MAP). Using MAP through DUCADE can aid the designer in generating designs for assembly and manufacturability while concurrently engineering between disciplines. The result of these additions will enrich the DUCADE environment and IMADE system tremendously.

UC Berkeley established an experimental fabrication testbed for an Internet-accessible, computerized machining service called *CyberCut*. Client-designers can now create mechanical components, beginning with a CAD system of their choice, and submit appropriate files to the server at UC Berkeley for process planning. *CyberCut* utilizes an existing open-architecture, computerized machine tool at Berkeley for fabrication. Rapid tool-path planning, novel fixturing techniques, and sensor-based precision machining techniques allow the original designer to take delivery of a component with high-strength and tight-tolerance (e.g. $\pm 0.05\text{mm}$). As the work proceeds, other services such as laser-

cutting and precision machining will be included. *CyberCut* will first be used by university collaborators at Carnegie Mellon, Stanford, and the MTAMRI at Illinois.

Concurrent engineering through the smooth transfer of information between various CAD programs will reduce the design cycle significantly. The program aims are to replicate some of the organizational successes of the Japanese manufacturing sector in terms of improved quality and productivity by using technology as the lever.

A wide scope of several software packages is now available that addresses the needs that U.S. manufacturers have in relation to competing against Japan and other countries that specialize in the fabrication of consumer electronics products.

Project III. Environmental Issues in Supply Chain Management for Electronics Manufacturing. Professor Paul Sheng and Tse-Sung Wu.

This research project focused on the study of product design for environment (DFE) on supply chains in the computer sector, with emphasis on printed circuit board fabrication and assembly. The project developed a set of process models for printed circuit board manufacturing that predicted waste flows and energy consumption. These models were validated at a number of manufacturing facilities to evaluate how operating strategies at different firms result in different waste flows. The goal also was to better understand the similarities and differences between a U.S.-based supply chain and a Japanese-based supply chain. Data collection was aided through a partnership established with the Microelectronics and Computer Technology Consortium (MCC) based in Austin, Texas. The following tasks were performed.

1. Collected manufacturing data on energy and mass wastes produced by a typical computer supply chain in collaboration with Sun Microsystems, Solectron, and Hadco. Compared results with aggregate data from Sony Corp. in Japan in collaboration with Mr. Hideaki Karamon, manager, Environmental Technology, Sony.
2. Developed generic process models to predict waste generation and to model facilities for environmental performance. Developed a worldwide web interface to access the board assembly model remotely through the Internet (www.me.berkeley.edu/green).
3. Validated the process models through data collection efforts at IBM (Austin, TX), Computing Devices (Minneapolis, MN), and Motorola (Schaumburg, IL). Also validated the data through communications with NEC Corp. (Central Research Lab, Kawasaki, Japan) and Sony Corp. (Tokyo, Japan).
4. Gave presentations to Sony Corp., Hitachi Production Research Lab and NEC Corp. to validate design for environmental implementation. Also discussed DFE strategic implementation with Samsung and Daewoo to obtain generalized perspective from Asian firms.

5. Presented initial research findings and models to MCC, IBM, Ford Motor Co., Hughes Aircraft Co., SAIC, and Boeing.

Professor Sheng also focused on dissemination of environmental practices of U.S., Japanese and European firms. Product design-for-environment has become an emerging topic of importance in U.S. industry, driven by the regulatory environment for manufacturing emissions, nascent environmental certification requirements worldwide (ISO14000, British Standards 7750, etc.), a growing consumer preference for "green" products, European community product take-back initiatives governing end-of-life, internalization of environmental costs for abatement and disposal of wastes into the production costs, and the globalization and disintegration of manufacturing supply chains in many industries.

One issue facing multinational companies is how to address the regional environmental requirements while maintaining cost-efficient product development. Extensive fieldwork was conducted to study how environmental factors are integrated into product design efforts. One case study was how European initiatives caused Sony to rethink their product development strategy. The question arose whether Sony should develop a worldwide standard for "green" TVs and risk losing market share in the United States and Japan based on price, or should they bifurcate product development to design regional products? The growth of eco-labeling standards in Japan, the U.S. and Europe has led companies to seek out uniform measures of product environmental performance. This research continues as the researchers broaden their scope of work to include other Japanese, U.S. and European companies.

Funds from this grant supported Paul Worhach, a PhD student in Industrial Engineering, to work on this project. Worhach developed the process models and surveyed electronics manufacturing environmental practices.

There is a strong link between these research activities and the U.S. industry's interest in and use of these findings. Seminars to discuss relevant research issues were held at UC Berkeley, and information exchange sessions were conducted with engineers from various companies (Matsushita, Hitachi Production Research Lab, MITI Mechanical Engineering Lab).

Project IV. Alternative Methods for Manufacture and Finishing of Precision Parts.
Professor David Dornfeld.

The manufacture and finishing of precision parts, such as those found in computers and high-technology hardware, are generally expensive and little basis exists for the integrated design and manufacture of these components. This project developed the basis for software to analyze and plan aspects of precision component manufacture and part finishing (for example, deburring) using novel technology. This project integrates with the process planning efforts of Professor Paul Wright (see Project II) for open architecture machine control and Professor Paul Sheng (see Project III) for green design and manufacture of precision parts.

The faculty and students involved in this project had extensive interaction with the Japanese finishing and precision machining associations and industry. With respect to the Japanese efforts in this area, this project suggests that U.S. efforts are substantially ahead in terms of linking process models with design tools for product realizations.

Project V. The Influence of Team Diversity and Organizational Culture on Innovation in Large U.S. Research Establishments. Professor Jennifer Chatman.

With research funds from this grant and from a grant from Los Alamos, Professor Chatman was able to survey thirty project teams and their members at the Los Alamos Laboratory (LANL). Members of the project teams were assessed regarding their personality and normative beliefs affecting collaboration within and across units at LANL and team performance was assessed with regard to the impact of financial incentives, work-related diversity and other factors.

Funds from this grant supported Rebecca Brown, a PhD student at the Haas School of Business, who used findings from the above project in her doctoral dissertation.

Project VI. Key Factors in Diffusion of Japanese Quality Paradigm to American Industry. Professor Robert Cole.

Professor Cole completed research work on the diffusion of the Japanese quality paradigm in U.S. industry, and how quality improvement activities have been implemented over the last 15 years. This project explored the problems and obstacles U.S. firms have faced in adopting the new quality paradigm developed in Japan. It had taken far longer for the U.S. to adapt than many anticipated, and in the process many jobs and much capital had been exported to other countries. This project identified critical factors involved in the diffusion process and put it into perspective using the most relevant social science theories. Of particular interest is the circuitous path by which many quality practices entered American industry since relatively few U.S. companies were willing to directly learn from the Japanese. The period of study was from 1980 to the present, examining specifically the experiences of the electronics and auto industries.

These research findings culminated into two books. The first book, *Managing Quality Fads: How American Business Learned to Play the Quality Game* (Oxford University Press), examines the process by which American firms partially absorbed the Japanese quality paradigm, and explains how managers made decisions when faced with strong competitive challenges. Cole characterizes the institutional arrangements, which initially inhibited the adoption of the Japanese quality paradigm, and the emergent institutional infrastructure, which facilitated the partial adoption and adaptation of these practices.

Cole's second book, *The Quality Movement in America: Lessons for Theory and Research* (Sage Publications), co-edited with Richard Scott, includes contributions of leading social scientists working in the quality area. These contributions came from a conference on "Integrating the Study of Quality into the Social Sciences" held at UC

Berkeley in 1997. This conference brought together 20 scholars doing cutting edge research on quality as well as prominent organizational theorists. They gathered to examine research on the aspects of the quality improvement model and how it could be integrated into contemporary organizational theory.

Professor Cole continues his research on the Knowledge Creation and Transmission of New Quality Concepts project. This project clarifies the role of the center (corporate offices) in the spread of best practices to highly autonomous decentralized units in the multi-divisional corporation and is based on an intensive study of Hewlett Packard Company. He has presented his research findings to various audiences including managers of multinational organizations. He is currently completing data collection for a project on new venture activities in Japanese and U.S. high-tech industries. Working papers are available for both these projects.

Project VII. Patterns and Objectives of Strategic Alliances. Professor Michael Gerlach.

Professor Gerlach's continuing agenda of studying business network ties that originally began with his seminal book on the *keiretsu*, developed further to focus on the forms and characteristics of strategic alliances. Gerlach investigated what variables predict the type of strategic alliance that partner firms choose, and whether this varied in systemic ways by whether the partner was Japanese or American, by the nature of the activities involved, by industry, or by other factors. This research has provided important findings on the growing tendency to create strategic alliances, particularly in high technology industries where the economic, and sometimes political, costs of "going it alone" have often become prohibitive. A major portion of grant funds allocated to this project were spent identifying the appropriate databases for conducting this type of analysis and putting them in a form conducive to quantitative analysis. This research will culminate in a section of a forthcoming book co-authored with Haas School of Business professor James Lincoln.

II. BUSINESS TECHNICAL JAPANESE LANGUAGE PROGRAM

Under the leadership of Professor Yoko Hasegawa, AFOSR funds have supported the Business Technical Japanese Language Program staff. This business language program achieved positive results in developing requirements and implementing the instruction of business Japanese classes at UC Berkeley for students in business, engineering and other disciplines. In addition to Professor Hasegawa, Mmes. Tomizuka, Shibahara, and Suda staff the teaching program. All have extensive experience in this area.

The language proficiency goals for this program were based on ability in both speaking/listening and reading/writing, with an emphasis on the vocabulary and expressions most used in business and/or technical settings. Computer-aided instruction software programs Mikan and JapanEase, as well as Nisus, a Japanese word processor, and Mikan, a Primer to Japanese Economics, assisted vocabulary building performance in

katakana and kanji. Additional skills were achieved through the use of TV for Japanese broadcasts and videotapes to teach business manners and verbal communication. Internet services were established for students to access the Japanese programs hosted on the Instructional Technology Program server.

In order to provide an objective measure for evaluating their teaching effectiveness, every year the faculty conduct the Japanese Language Proficiency Test, the most authoritative standardized test of the Japanese language administered jointly by the Japan Foundation and the Association of International Education, Japan. To our knowledge, we are the only Japanese language program at a major U.S. university that administers the Japanese Language Proficiency Test. Japanese universities use this test to evaluate the suitability of non-native speakers seeking to enter Japanese universities. In this sense it is comparable to the TOFL tests used by U.S. universities. We found that students in the business and technical courses did extremely well in these tests, adjusting for level of exposure to the language. For each level they performed as well as or better than those students studying Japanese in Japan did. This is quite remarkable. In addition, students in the business and technical Japanese courses performed better than those students in regular Japanese track classes. We are unable to explain this, but it is likely a mixture of smaller class enrollments in the business and technical classes (better student/teacher ratios), possibly higher motivation, and greater prior language experience.

Classes Offered in Business and Technical Japanese

JBIA – Nihongo de bijinesu kaiwa: shokyuu-hen (Business Conversation in Japanese: elementary)

JB10A – Nihongo de bujinesu kaiwa: Chuukyuu-hen (Business Conversation in Japanese: intermediate)

JB100A – Talking Business in Japanese

JB1B, JB10B, JB100B – Business and Technical Japanese

Enrollment of students from business, engineering, and other disciplines.

Fall 1994	97
Spring 1995	71
Fall 1995	108
Spring 1996	74
Summer 1996	12
Fall 1996	74
Spring 1997	57
Fall 1997	65
Spring 1998	39
Fall 1998	27
Spring 1999	21

III. FELLOWSHIPS AND INTERNSHIPS

A. Fellowships

One of the most important uses of AFOSR funds has been to support our students through a combination of fellowship and research assistantships. PhD students and their research topics that were supported with AFOSR funds are listed below.

Academic year 1994-95

Eric Thacker, PhD candidate in the Haas School of Business, studied the Japanese language at the Inter-University in Yokohama. During his time in Japan, he also conducted field research for his doctoral dissertation on technology management-related issues and Japanese semiconductor firms' management of new manufacturing process introduction.

Academic year 1995-96

Judith Biewener, PhD candidate in the Dept. of Sociology, worked with Professor Cole on a variety of infrastructure projects.

David Busing, PhD candidate in Industrial Engineering and Operations Research, worked with Professor Leachman on strategies for improving equipment efficiency analysis using data from the international semiconductor study.

Bonnie Chen, PhD candidate in Business and Public Policy at the Haas School of Business, worked with Professor Sara Beckman on various software projects.

Brian Duncan, MBA student, assisted in administering the Management of Technology Forum that brought leading managers to UC Berkeley to discuss their experiences.

Rose Marie Ham, PhD candidate in Business and Public Policy at the Haas School, conducted research with Professor David Mowery on analyzing the effects of research consortia. Research consortia was a prevalent form of organization that was popularized in the 1980s by firms to conduct joint R&D projects, and was used in particular by Japanese firms in high-tech industries.

Kyle Mayer, PhD candidate in Business and Public Policy at the Haas School, conducted research on software development, how firms use embedded software, and buyer/supplier relationships.

Michael McGregor, PhD candidate in Organizational Behavior at the Haas School, conducted research on statistical analysis of quality managers as part of Professor Cole's project on how the United States absorbed Japanese quality practices.

Arvids Ziedonis, PhD candidate in Business and Public Policy at the Haas School, conducted research with Professor Mowery on spin-offs of technology from Lawrence Livermore National Lab, licensing of university technology, and university/industry technology transfer.

Academic year 1996-97

We supported a benchmarking trip for graduate students in the Haas School of Business and the College of Engineering in September 1997 to Asia to visit Asian semiconductor companies. The students studied practices and performances in managing new wafer fabrication plans and new process development, focusing on companies marketing memory devices and advanced logic devices and those providing general foundry services. The students interviewed managers, observed practices in various factories, and benchmarked Japanese experiences against others. This unique experience provided them with information and opportunities to compare practices cross-nationally, information which otherwise would not be obtainable. This experience was sponsored by AFOSR funds as well as funds from the Alfred P. Sloan Foundation and its Competitive Manufacturing Program.

Other support was as follows.

Naomi An, PhD candidate in Mechanical Engineering, worked with Professor Paul Wright on the DUCADE project. Her focus was on vertical robotic assembly interfaces.

David Busing, PhD candidate in Industrial Engineering and Operations Research, worked with Professor Leachman on strategies for improving equipment efficiency analysis using data from the international semiconductor study.

John deFigueiredo, PhD candidate in the Haas School of Business, worked with Professor David Teece on competitor sourcing strategies in the laser printer industry, comparing Hewlett Packard's use of collaboration with Canon for printer engines and the strategies of other U.S. and Japanese producers of laser printers.

Francis Flynn, PhD candidate in the Haas School of Business, worked with several faculty in the field of Organizational Behavior to explore the impact on organization commitment by telecommuting employees.

Rose Marie Ham, PhD candidate in the Haas School of Business, continued her research with Professor Mowery on analyzing the effects of research consortia. Ham's efforts concentrated on developing a more direct way to measure some of the welfare effects and studied several large-scale research consortia in the semiconductor industry. Ham also lectured for the Japanese Management of Technology class on Japanese approaches to patent protection.

Jeff Macher, PhD candidate in the Haas School of Business, worked with Professor Michael Gerlach on "cleaning" the ITSA database by cataloguing over 9,000 worldwide business alliances from the early 1980s through 1994. This work was critical to testing

various hypotheses relating to similarities and differences in the forms and characteristics of strategic alliances created by U.S. and Japanese firms.

Paul Worhach, PhD candidate in Mechanical Engineering, worked with Professor Paul Sheng to develop process models. Worhach also surveyed electronics manufacturing environmental practices.

Academic year 1997-98

Lisa Epstein worked with Professors Robert Cole and Robert Sutton on technical innovation center research – organization structure and managerial intent versus action.

Rose Marie Ham worked with Professor David Mowery on spillover diffusion effects of SEMATECH research consortium on member firms' innovative activities. They analyzed the effects of research consortia, a prevalent form of organization that firms use to conduct joint R&D projects popularized in the 1980s, in particular by Japanese firms in high-tech industries.

Jeff Macher, PhD candidate in the Haas School of Business, worked with Professor David Mowery on new process introductions within the semiconductor industry. Macher also focused on contractual and relational alliances in fabless semiconductor association regarding wafer demand.

Dragos Maciuca, PhD candidate in Mechanical Engineering, was given a fellowship to study the modeling and control of automotive systems used in the automatic operation of a motor vehicle in an Intelligent Vehicles and Highway System (IVHS) environment. Maciuca focused on the modeling and control of brake systems.

Robert Scott North, PhD candidate in Sociology, worked with Professor Cole on network roles in the diffusion of quality practices.

Dimitry Ritschev, PhD candidate in the Department of Economics, studied the nature of Japan's competitive strength in a variety of high-tech industries. He co-authored with Professor Robert Cole a paper on institutional barriers for successful Japanese startups in high-tech industries.

Thomas Nitsch, PhD candidate in Industrial Engineering and Operations Research, studied the impact of product variety on work organizations, comparing approaches at Toyota and Chrysler. Nitsch used this research as the core of his PhD dissertation.

Academic year 1998-99

Garrick Blalock, PhD student in Business and Public Policy in the Haas School of Business, completed research with Professor Mowery on institutions of international capital flow and how these institutions impact regional economic development in Asia.

Christopher Boerner, PhD student in Business and Public Policy at the Haas School, studies the regulatory environment in which the pharmaceutical industry operates and how firms strategically manage the regulatory process.

Stuart Graham, PhD student in Business and Public Policy at the Haas School, focused his studies on the institutional supports necessary for the creation maintenance of localized agglomeration economies.

Rose Marie Ham, PhD student in Business and Public Policy at the Haas School, continued her studies of the welfare-enhancing effects of a large research consortium in the semiconductor industry.

Gwendolyn Lee, PhD student in Organizational Behavior at the Haas School, studied the effects of organizational structure and technology on process knowledge creation and diffusion.

Robert Lowe, PhD student in Business and Public Policy at the Haas School, studied the response capabilities to market opportunities using dynamic capabilities and corporate strategy literature.

John Lamar Pierce, PhD student in Business and Public Policy at the Haas School, focused on a comprehensive study of leasing practices for manufacturers in the automotive, airplane, and several high-tech industries.

B. Internships

Academic year 1994-95

Eric Thacker, PhD candidate in the Haas School of Business, studied the Japanese language at the Inter-University in Yokohama. During his time in Japan, he also conducted field research for his doctoral dissertation on technology management-related issues and Japanese semiconductor firms' management of new manufacturing process introduction. Thacker worked closely with NEC Corp. in Japan.

Carl Kempf, a PhD candidate in the College of Engineering, studied and worked at NSK, the leading ball bearing manufacturer in Japan. Kempf's project covered development and application of control algorithms for high speed and high precision electro-mechanical systems. His work concentrated on direct-drive motors and focused specifically on automated wire-bonding equipment for microelectronic manufacturing.

Summer 1996

AFOSR funds sponsored four engineering students to participate in the Engineering Alliance for Global Education (EAGLE)/Japan Program. They studied Japanese language and culture training in Kanazawa, Japan, during the summer. The students and their field of study are: Joyce Feng, Civil Engineering; Salim S. Jordan, Electrical

engineering and Computer Sciences; Albert Chi Fu To, Civil Engineering; Raymond Satoru Yakura, Electrical Engineering and Computer Sciences/Economics/Molecular Cell Biology.

Academic year 1995-96

Carl Kempf, PhD, College of Engineering, completed post-doctorate research at NSK, the leaving ball bearing manufacturer in Japan. Kempf's continued his research on the development and application of control algorithms for high speed and high precision electro-mechanical systems. His work concentrated on direct-drive motors with specific focus on automated wire-bonding equipment for microelectronic manufacturing. His research has been so successful that NSK invited Kempf to stay for another year.

Summer 1996 Intern

William Webster, Associate Dean, College of Engineering, and one staff member spent a week in Japan to become familiar with the new JETRO program. Professor Cole met with Dean Webster and his staff following the trip and they agreed to expand recruitment activities for Japan internships among engineering students.

Summer 1997 Interns

The US-JITMTP Program set up several summer internship positions. We also collaborated with the MITI internship program by working closely with the College of Engineering and the Haas School of Business to place students in internship positions with Japanese firms. These internships provided an important opportunity for the students to develop relationships and skills that may be the basis for future technological cooperation between technology firms worldwide.

Beau Fernald, student in College of Engineering, completed a summer internship at Superstation Inc.

Tina Smilkstein, student in the Computer Sciences Reentry Program, completed a summer internship with Nippon Electronics.

Ryohei Urata, student in the College of Engineering, completed a summer internship at Nippon Telephone and Telegraph Company.

Academic year 1997-98

Dragos Maciucă, PhD candidate in Mechanical Engineering, interned with Nissan Research Center, Yokosuka, Japan from August through December 1997. Maciucă's project involved the modeling and control of automotive systems used in the automatic operation of a motor vehicle in an Intelligent Vehicles and Highway System (IVHS) environment, specifically the modeling and control of brake systems.

Dimitry Ritushev, PhD candidate in the Department of Economics, interned at RCAST at the University of Tokyo, Fall 1997. He research included the nature of Japan's competitive strength in a variety of high-tech industries. He co-authored with Professor Robert Cole a paper on institutional barriers for successful Japanese startups in high-tech industries.

Thomas Nitsch, PhD candidate in Industrial Engineering and Operations Research, interned in the summer of 1997 at Toyota Motor Supplier Center in Lexington, Kentucky. Nitsch's work studied the impact of product variety on work organizations, comparing approaches at Toyota and Chrysler.

Terry Whalen, MBA student, was sponsored as a summer intern for the Management of Technology Program at the Haas School of Business to conduct research on high-tech firms in the Bay Area.

Summer 1998 Interns

The US-JITMTP Program collaborated with the MITI internship program by working closely with the College of Engineering and the Department of Mechanical Engineering. The following Haas School of Business and College of Engineering students held internship position with Japanese firms. These internships provided an important opportunity for the students to develop relationships and skills that may be the basis for future technological cooperation between technology firms worldwide.

Gregory Bateman, student in Electrical Engineering and Computer Sciences, completed a summer internship with NEC Corporation in Kanazawa, Japan.

Yui-Tak Lee, student in Electrical Engineering and Computer Sciences, completed an internship from June - December 1998 with Nippon Telephone and Telegraph Corp. in Tokyo.

Bruce Lo, student in Electrical Engineering/Computer Sciences and the Haas School of Business, completed an internship from June - October 1998 with Nippon Electronics Development, Ltd. in Tokyo.

Aileen Oka, student at the Haas School of Business, completed a summer internship with Nikkei Business Publications in Tokyo.

Tina Smilkstein, Computer Sciences Reentry Program, completed a summer internship with Nippon Telephone and Telegraph Company in Tokyo.

Summer 1999 Interns

Brian Foster, PhD candidate in Engineering and Physics, started an internship with Shindengen Electric Manufacturing Company.

IV. MANAGEMENT OF TECHNOLOGY

Throughout the program, we aimed to achieve synergies between the US-JITMT program and the UC Berkeley Management of Technology (MOT) program. These efforts have accelerated since 1997 due to the appointment of Professor Cole as Director of the MOT program.

The MOT program continues to grow with more business and engineering students actively involved. This increase is also evident by the number of MOT certificates issued for course completion. Certificates awarded for past academic years are as follows: 1994-1995 – 31; 1995-96 – 52; 1996-1997 – 63, 1997-1998 – 63; 1998-1999 – 64; 1999-2000 – 59 for a total of 336.

MOT class size and new class offerings have been added to the curriculum. Three new courses have been added: High-Tech Marketing for Engineers, Technology Trends and Topics, and a flagship course, Introduction to Management of Technology (Spring 2000).

V. OUTREACH

A. Conferences

Annual Workshops and Forums on *Knowledge and the Firm*.

September 28-29, 1997: Knowledge Dynamics and Innovation.

September 24-25, 1998: Knowledge Creation and Transfer.

October 14-15, 1999: Building Competitive Advantage in the Knowledge Economy.

The Workshops annually bring together 40 leading academics and business executives to build and to deepen our understanding of the role of knowledge in the firm. The Forums focus on the business implications of knowledge creation, transfer, protection and use. Presentations and panel discussions provided historical as well as contemporary perspectives on the fundamental business issues of our time. The Forum, open to the public, draws more than 300 attendees each year. The first Workshop and Forum in 1997 led to a special issue on 'Knowledge and the Firm' published by *California Management Review*, Summer 1998, and edited by Professor Robert E. Cole. This issue has become the best selling volume by the *Review*, and one of the articles received the Anderson Consulting Award for the best articles of the year. The second and third Workshops and Forums will lead to a forthcoming book, Managing Industrial Knowledge (Sage Publications, October 2000). A major function of the forums has been the diffusion of the ideas of Professor Ikujiro Nonaka, one of the co-organizers.

December 17-20, 1998. Conference on "The Coming of the Information Intensive Century and Innovation in the Organization of the Firm. Co-sponsored with the Institute of Economic Research at UC Berkeley and Hitotsubashi University in Tokyo, this

conference, held in Hawaii, was designed to sketch out images of Japanese and U.S. companies for the coming century. The content drew on cross-disciplinary cooperation of social science specialists. Results from this conference will be published in selected articles in a special issue on 'Japanese Work and Labor Markets' in the *Industrial Relations* journal, forthcoming Winter 2001, vol. 40.

January 29, 1999. Conference on "Japan at the Crossroads." This conference included presentations from various academic and industry specialists, as well as a presentation from the Honorable Hitoshi Tanaka, Counsel General of Japan. Topics dealt with cross-disciplinary expertise in areas such as economics, management studies, intellectual property, human resources, and production management. Presentations focused on issues surrounding technology strategy in Japan and the degree of effectiveness of these various strategies viewed from a global perspective.

B. Technology Transfer in Japanese National Laboratories

In academic year 1996-97, funds from AFOSR sponsored a trip to Japan for Cheryl Fragiadakis, Head, Technology Transfer Department at the Lawrence Berkeley National Laboratory. Fragiadakis interviewed people from Japanese National Laboratories and other related institutions to gain an understanding of the objectives and methods of technology transfer used by Japanese organizations that most closely corresponded to U.S. national laboratories. Her focus was primarily on patent licensing and collaborative research, and on MITI-managed or funded laboratories. Engineering Research Institute; and Osaka National Research Institute.

Observations documented were as follows:

1. The licensing program appeared to be inefficient. It was estimated that only about 1% of patented inventions from the government labs are licensed out.
2. The decision to pursue patent protection for any given invention is not taken based on any informed estimate of commercial value. For example, the licensing function for the MITI Labs is handled by JITA, who receives the technologies after patenting but does not participate in the selection of what invention is worth patenting. As another example, all of the lab scientists and managers were asked about their decision-making criteria and whether any commercial information was used. In only one case did a scientist not have that information.
3. The importance of an effective reward system to provide incentives to inventors was recognized, and a more generous bonus/royalty sharing provision was to be enacted as a result of recent legislation. Current maximum royalty that an inventor could received was 3 million yen per year; the new maximum will be set at double that rate.
4. The labs and MITI perceived the mid- to late 1990s at a time of change. There had been an emphasis over the previous years on increasing "basic research" and evaluating progress based on publications. The labs are now being encouraged to

reach out and link more with industry, scientist to scientist – rather than just at senior planning levels.

5. Licensing of inventions from the government labs is completed on a non-exclusive basis. The rationale for this policy is the desire to spread the benefit of public-funded research as broadly as possible. It is recognized, at least by MITI, that this policy does not always result in successful commercialization.
6. Collaborative research is better developed in many of the Japanese labs than in their U.S. counterparts. Many of the labs have a long history of technical assistance and training for small- and medium-sized businesses. Many have industrial visitors. They do not have a program or practice of federal lab employees going out into industry. Many lab personnel expressed their belief that this would be illegal, although MITI described a program allowing some activity in that arena.

VI. DISSEMINATION

A. Lectures at Lawrence Berkeley National Laboratory (LBNL)

Joint Lecture Series – Academic Year 1994-95

Together with Stanford University, LBNL, and the UC Berkeley US-Japan Program, a lecture series was sponsored. The three speakers in this series were as follows:

November 22, 1994: Professor Nathan Rosenberg, Stanford Business School, spoke at LBNL on “Technical Change in the Medical Device Industry.”

February 7, 1995: Professor Eleanor Westney, Sloan School of Management at MIT, addressed an audience of LBNL personnel on “Comparative Trends in U.S. and Japanese R&D.”

March 15, 1995: John Mayo, former CEO at AT&T Bell Laboratory, addressed the LBNL and the LLNL personnel on “The Evaluation of Information Infrastructures: The Competitive Search for Solutions.” Dr. Mayo’s lecture was videotaped and used as a centerpiece for the U.S. Japan Industry and Management of Technology Program video series produced by Stanford University.

January 26, 1995: Cheryl Fragiakakis, Office of Technology Transfer at LBNL, and Professor David Gilbert, Department of Biotechnology at UC Berkeley, spoke at the UC Berkeley Entrepreneurs Forum on “Guns to Gadgets: Commercializing Our Nation’s Defense-Related Technologies.”

September 21, 1995: Workshop on the “Commercialization of Technology: Working with Early Stage Startups vs. Established Companies” was held with LBNL. The workshop examined the advantages and risks inherent in licensing new technologies in

startup ventures and how those problems differ from the ones encountered in dealing with large, well-established companies. The workshop was structured to help senior management and research at LBNL understand the different needs of the commercial organizations with which they work, and to become more customer focused in their cooperative arrangements.

November 15, 1995: Mike Kirk, Executive Director of the American Intellectual Property Law Association and former Deputy Commission of the U.S. Patent and Trademark Office, spoke on "Recent Development in Intellectual Property Protection. He emphasized the changes in the U.S. and foreign patent systems that had resulted from the recently concluded Uruguay Round of negotiations.

Feb. 23, 1996: Professor Richard Nelson, School of International and Public Affairs at Columbia University, and member of the Galvin Commission on the Future Mission of the Department of Energy Laboratories, spoke on the roles of public laboratories and universities in the U.S. national R&D system. Nelson's discussion included comments on the Galvin Commission's deliberations and recommendations for the DOE laboratory system.

April 8, 1997: Russ Irwin, Associate/Vice President, NEC USA, gave lectures at Lawrence Berkeley National Laboratory and on the UC Berkeley campus. His lecture, entitled "Technology Transfer: A NEC Perspective," explored various strategies Japanese subsidiaries like NEC use in acquiring technical information in the United States.

November 7, 1998: Hideo Setoya, Executive Director of the Association of Super-Advanced Electronics Technologies (ASET), was a speaker at the Management of Technology (MOT) Lecture Series. Setoya spoke on the organizational structure of ASET, a Japanese research consortium funded by the Japanese government, and ASET's future plans for the development of Japanese technological research and development projects.

Joint Lecture Series – Academic Year 1998-99: *The Many Dimension of Technology*
Funded by AFOSR and sponsored by the MOT program with the support of the Deans of the Haas School of Business and the College of Engineering, this series was designed to broaden the view of technology. Speakers throughout the year expanded the vision of technology by examining the topic through its cultural, economic, historical, and political dimensions. Speakers included Gideon Kunda, Sherry Turkle, John Seely Brown, and Shane Greenstein.

Gideon Kunda, Tel Aviv University and visiting professor at Stanford University, lectured on "The Cultural Dimensions of Technology." Kunda spoke about project schedules and deadlines as a constant in high-tech product development and how the constraints of time, money and other resources play themselves out as well as how they affect the way people involved organize their private lives.

Sherry Turkle, Professor of the Sociology of Science at the Massachusetts Institute of Technology, spoke on "The Psychological Dimensions of Technology." Turkle's lecture focused on the psychology of computer-mediated communications on the Internet, as well as computer simulation and virtual reality and their influence and affect on education and individual self-image.

John Seely Brown, Chief Scientist at Xerox PARC, covered "The Social Dimensions of Technology." Brown lectured on the role of corporate research including organizational and individual learning, ethnographics of the workplace, complex adaptive systems, techniques for unfreezing the corporate mind, and the management of radical innovation.

Shane Greenstein, Professor at the Kellogg Graduate School of Management at Northwestern University, covered "The Economic Dimensions of Technology." Greenstein lectured on the commercial provision of Internet access by Internet Service Providers (ISPs), and explored the geographic diffusion of ISPs and the expansion of their product lines in terms of the market for technology mediation. Greenstein showed how markets for technology mediation often involve experimentation with new business models, new cost structures, new applications and new services.

B. Newsletter

The *Consortium on Competitiveness (CCC) Newsletter* disseminates information on recent working papers by academics in the area of international cooperation and competition. The newsletter is distributed to a diversified international community of academics, industry managers, and lab personnel. Issues regularly featured research activities in the AFOSR program.

C. Academic Publications (See Appendix)

VII. CONCLUSION

Funding from AFOSR has allowed the United States-Japan Industry and Technology Management Training Program at UC Berkeley to maintain the integrity of our existing programs initiated with AFOSR funding and achieve the goals and objectives set forth in our grant proposal. Notable in our objectives and goals are the training and dissemination of material that reached beyond the academic community to leaders in industry. Our activities have expanded an awareness of Japan's technological capabilities, management strengths and weaknesses, as well as an awareness of the processes of technology management. We have used AFOSR funds to reach out to the community through Japanese language instruction, seminars, forums, workshops, newsletters, internships/fellowships, and faculty research. We are grateful for the funding we have received to support our educational program. Now that funding has expired, we expect to be able to maintain and expand many of the programs initiated with AFOSR funds.

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